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NP10 8QQ

REC'D 26 OCT 2000
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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Patents Form 1/77 THE PATENT OFFICE
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2 SEP 1999

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27SEP99 E479321-1 C55772
P01/7700 0.00 - 9922642.5

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference ~~QP3/A~~ GS/ P207043.

2. Patent application number *(The Patent Office will fill in this part)* 25 SEP 1999

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* 9922642.5

QUALITY SENSOR SYSTEMS LTD.
GREENFIELD BUSINESS CENTRE,
GREENFIELD
FLINTSHIRE,
CH8 7GR

Patents ADP number *(if you know it)* 75106613001

If the applicant is a corporate body, give the country/state of its incorporation UNITED KINGDOM

4. Title of the invention AN APPLICATION SPECIFIC CHEMICAL SENSING SYSTEM

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

~~QUALITY SENSOR SYSTEMS LTD.~~
~~GREENFIELD BUSINESS CENTRE~~
~~GREENFIELD~~
~~FLINTSHIRE~~
~~CH8 7GR~~

URQUHART-DYKES & LORD
TOWER HOUSE LEEDS
MERRION WAY LS2 8PA.

Patents ADP number *(if you know it)*

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
N/A		

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*
N/A	

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* YES
   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

An Application Specific Chemical Sensing System

This invention relates to a chemical sensing system for gas and/or vapour analysis. More specifically, it relates to an improved implementation of array based chemical sensing systems for gas/vapour analysis. Array based sensing systems have been the subject of much research during the past decade and a half. [J.W. Gardner & P.N. Bartlett, *A brief history of electronic noses*, Sensors & Actuators B, 1994, **18-19**, 211; and S.L. Rose-Pehrsson, J.W. Grate, D.S. Ballantine, P.C. Jurs, *Detection of Hazardous Vapours Including Mixtures Using Pattern Recognition Analysis of Responses from Surface Acoustic Wave Devices*, Anal. Chem., 1988, **60**, 2801.] A substantive improvement to such systems has been gained by designing the sampling system especially for the specific application it addresses. Although embodiments of the invention may be used for any application where gas/vapour phase measurements are necessary, or desirable, the embodiment illustrated here is by way of an example for screening for volatile components in paperboard cartons and related raw materials.

The Analytical Chemist has an extensive range of techniques and instrumentation available to him to address the problem of Quality Control (QC) in production. Such techniques are however confined to the remote laboratory, under the direction of trained personnel. There is an increasing demand to improve QC procedures, to reduce production mistake costs. Bringing QC techniques to the factory floor, for at- and on-line QC, using technology designed for non-technical operators, is extremely beneficial to many manufacturing industries.

According to the current invention there is provided an improved array based chemical sensing system for use in at- and on-line QC procedures. The system:

- software is the 'expert', determining how data is collected, processed and analysed. Thus non-technical operators are not required to draw conclusions from the data;
- requires no sample preparation for use; and,
- is fast, answers being rapidly made available to the operator.

The embodiments of the invention implement improvements to array based chemical sensing systems. Namely, the system:

- is supported by 'expert' software, allowing use by non-technical operators;

- supports system '[illegible]-checking' procedures to track sens[illegible]nd components reliably and to implement array calibration;
- supports application specific sampling mechanisms, thus improving sample delivery to the sensors; and,
- materials are resistant to sample absorption, minimising any cross-contamination.

The embodiment comprises an array (number) of chemical sensors, each of which may respond to a given chemical stimuli. The array might well comprise, or include, bulk or surface acoustic wave devices, metal oxide sensors, conducting polymer sensors or optical sensors. The array is housed in a sensor block (1, Figure 1), which allows gas to flow over the sensors (2, Figure 2) in a 'wall jet' fashion. The sensors, which are represented in Figure 2, are bulk acoustic wave devices. The sensor block (1), which is constructed of an inert material, is connected directly to the electronic circuitry (3, Figure 3), the combined unit herewith referred to as the sensor board (4, Figure 3).

The sensor board maybe controlled by a microcontroller (6, Figure 4), which takes instructions directly from a PC down an RS232 line (9, Figure 4). The sensor board microcontroller (6) controls each sensor transducer (5, Figure 4), drive and output, and controls the temperature (7&8, Figure 4) of the sensor block, via a feed-back mechanism. The temperature control electronics allow for heating and cooling of the sensor block.

A control board (10, Figure 5) for the sampling system, may also be controlled by its own microcontroller (13, Figure 5), again, directly controlled from the PC (9, Figure 5). Commands can be issued from the PC to the microcontroller during use or whole sampling routines downloaded and then subsequently executed. The control board controls the switching of a pump (11, Figure 5) and a series of valves (12, Figure 5), and the temperature of the sampling chamber (14, Figure 5). The control board may also support a series of LED's or a LCD panel to indicate the status of the instrument.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 represents a cross-section through the sensor block.
Figure 2 illustrates the 'wall-jet' effect of the gas flow through the sensor block.

Figure 3 shows how the sensor block push-fits onto the electronics board to form the whole sensor block assembly.

Figure 4 represents the transducer and temperature control of the sensors, by a microcontroller on board the sensor board, controlled directly from a PC.

Figure 5 represents how the pump, a series of valves and the temperature of the sample chamber may be controlled by a microcontroller on board a control board.

Figure 6 illustrates the gas flow of the system.

Figure 7 illustrates an application specific sampling mechanism, in the present embodiment for use in paperboard applications. (A) depicts the chamber mount, (B) & (C) depict the chamber bottom and top respectively and (D) is a representation of the whole sampling assembly.

During use a gas or vapour is drawn from the sampling chamber (14, Figure 6), through the system 'internals' and over the sensors (2 in 1, Figure 6). The embodiment 'internals' comprise a pump (11, Figure 6), a series of valves (12, Figure 6) and connecting pipework (16). The valves and pump are controlled by a microcontroller (13, Figure 5), to allow the gas flow to be directed around the system, as is necessary and to allow filtered (15, Figure 6) air to be drawn over the sensors to clean them after use. The choice of materials for the 'internals' is important, the use of materials which are chemically inert, eliminate the reliance on the system to remove absorbed gases, by flushing with filtered air.

It is preferable to design the sampling chamber to the specific application, so as to account for the sample type (gas, liquid or solid), the sample size and/or shape, and considerations such as destructive or non-destructive sampling.

A specific example of a customised sampling chamber will now be described by way of an example of paperboard quality control applications. The paperboard sample (cut to a pre-determined size) is placed into the bottom of the sampling chamber (21, Figure 7B) and the top of the sampling chamber (25, Figure 7C) secured to the bottom (21) by means of a screw thread (23, Figure 7C) to form a complete assembly. The sample chamber will be made from a chemically inert material and an 'O'-ring (26, Figure 7C) provides a gas-tight seal between the two halves of the chamber. Supports (24, Figure 7C) for the sample provide a gas-flow path across both sides of the paperboard. Complete chambers may be manufactured from materials, which would enable the chamber to be disposable, or from materials that would

allow cleaning and reuse. Either way, a number of these chambers may be used concurrently, to allow samples to be collected and then analysed later.

The sample chamber, containing a sample to be analysed, is engaged with rest of the instrument simply by pushing the complete chamber assembly into the chamber mount (17, Figure 7A). A complete gas flow path is now attained by the alignment of the gas channels (18, Figure 7A) on both the chamber bottom (21) and mount (17). The correct alignment is aided by the locating pin (20, Figure 7A) and the locating pin hole (22, Figure 7B). The gas-tight seal between the sampling chamber and the chamber mount and the separation of the 'gas in' and 'gas out' paths is achieved by three 'O'-rings (19, Figure 7A).

Gases or vapours, be it a single gaseous component or a complex gas or vapour mixture, when drawn over the chemical sensors, will interact to varying extents with each of the sensors in the array, resulting in a time-dependant response profile for the sensor array, which is characteristic of that sample. The embodiment represents the data from a number of sensors in two (or three) dimensions by implementing data reduction techniques. Statistical methods for defining x% confidence intervals on multi-variate sample populations, in conjunction with the above data reductions, maybe used to draw conclusions as to the identity of the 'unknown' sample. The sophisticated data processing routines, including allowable and non-allowable options, are hidden behind an 'expert' software user interface. The analysis results provided by the embodiment can be as simple or as complex as desired, i.e. a simple pass/fail answer can be provided, with or without a certainty value, or conclusions may be drawn as to the possible identity of the species.

Drawings

Figure 1

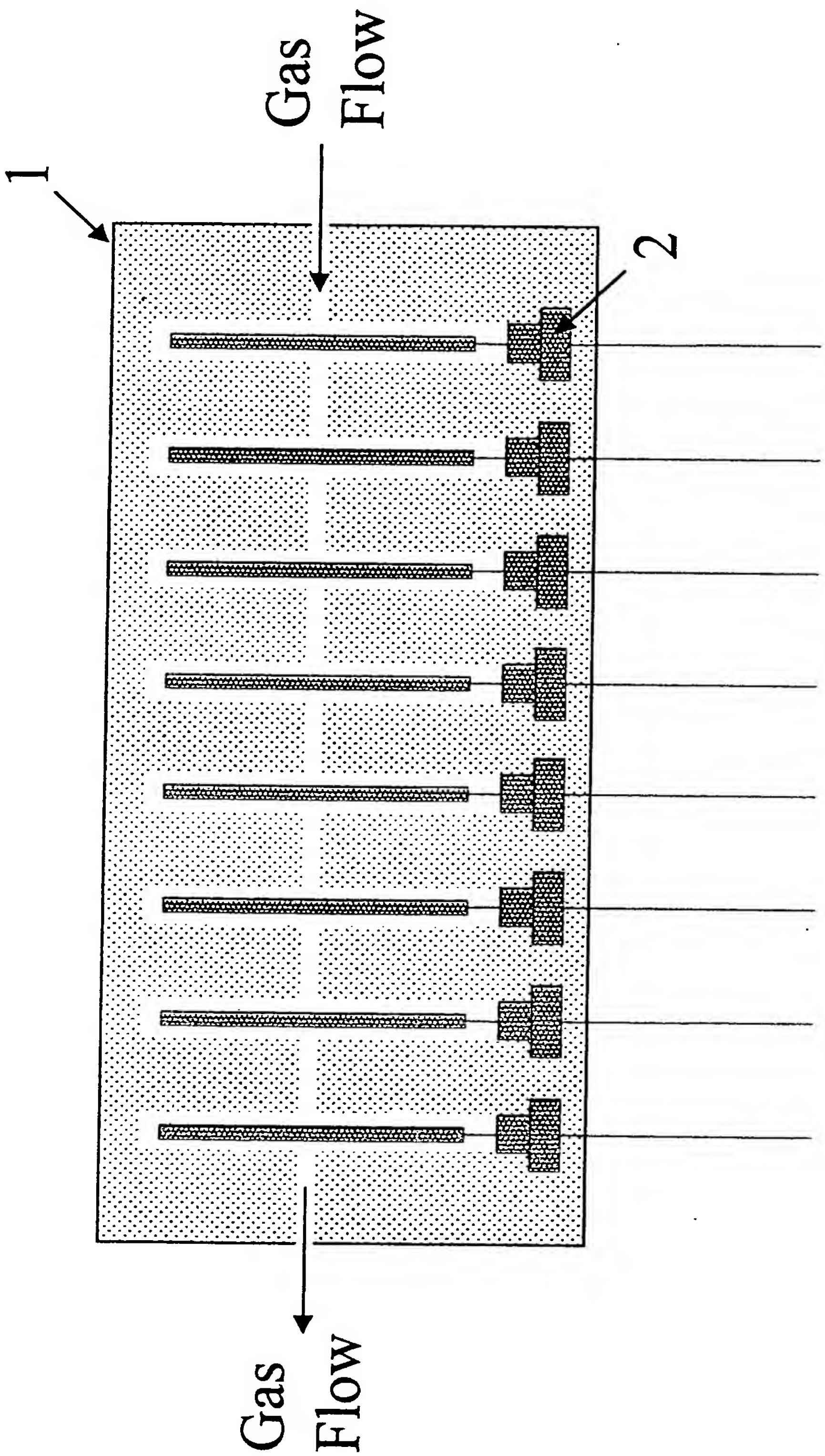

Figure 2

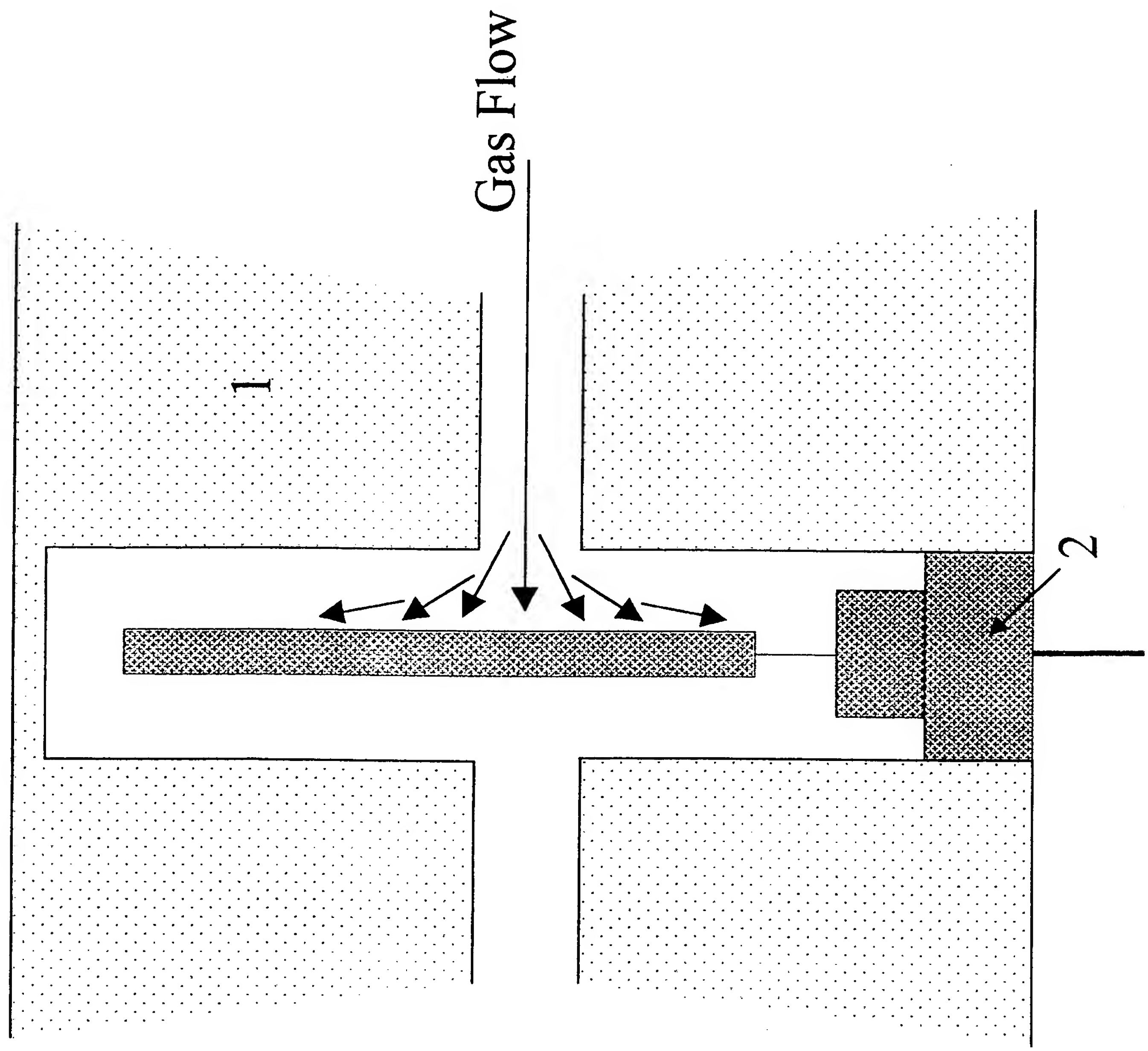

Figure 3

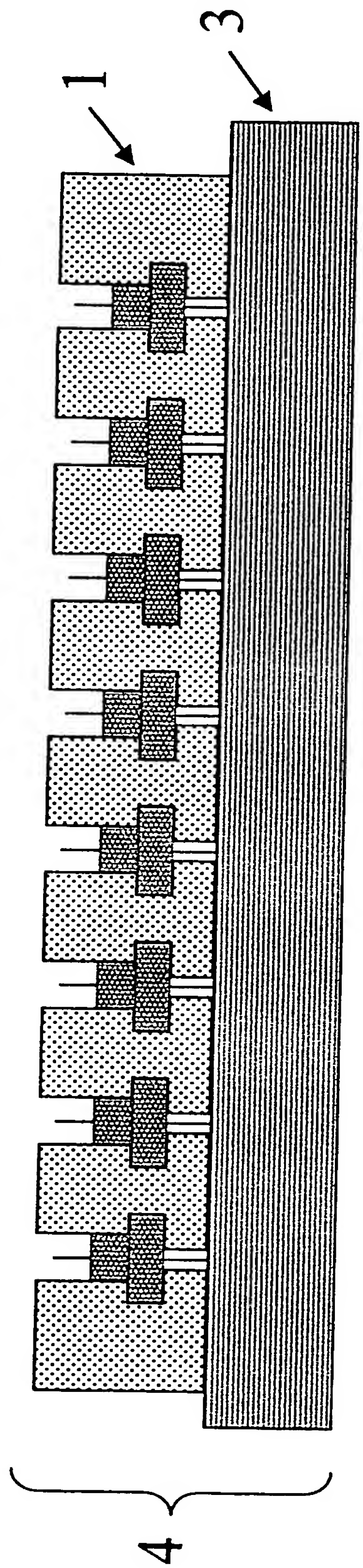

Figure 4

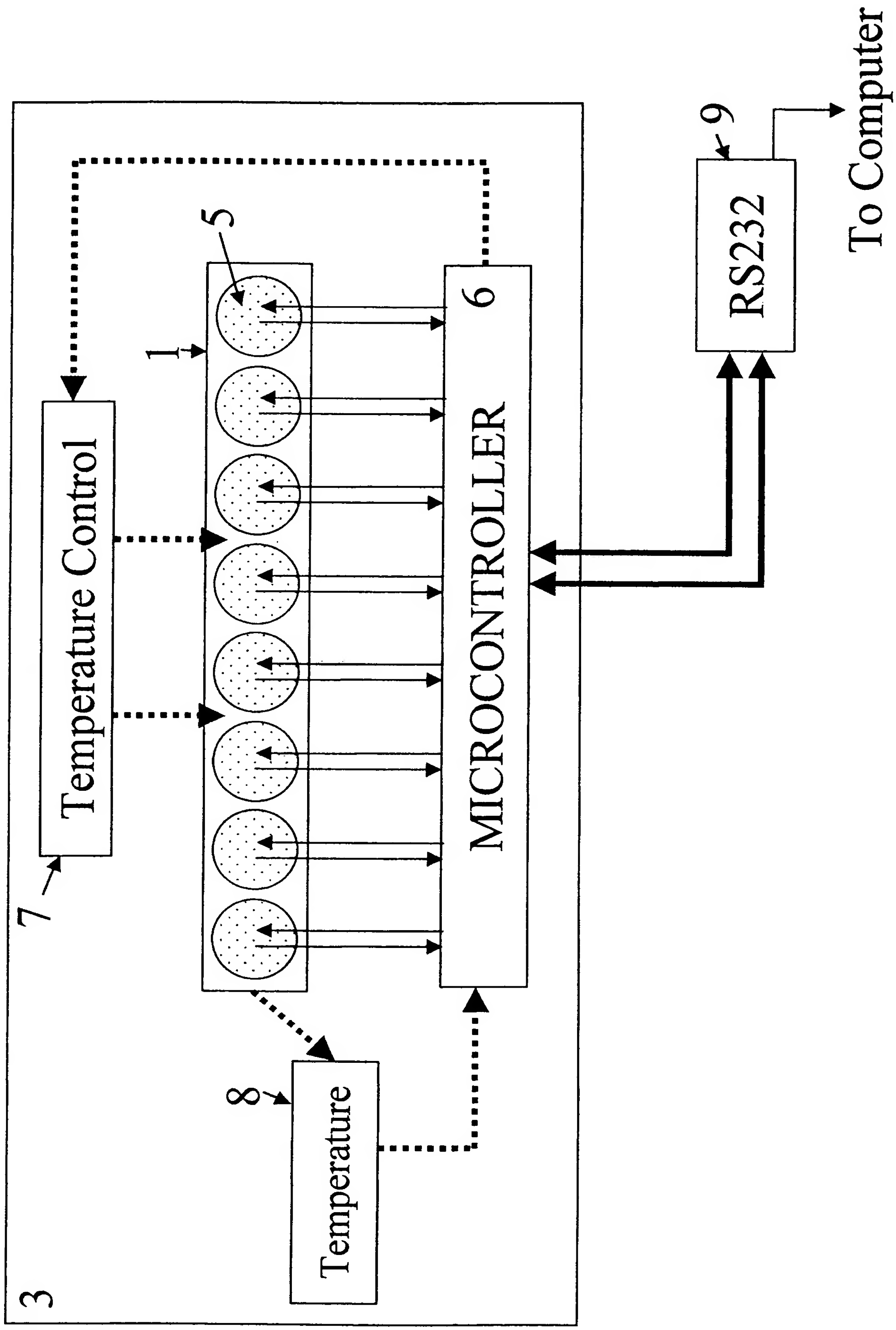
To Computer
9
RS232
5
6
1
Temperature Control
MICROCONTROLLER
7
8
Temperature
3

Figure 5

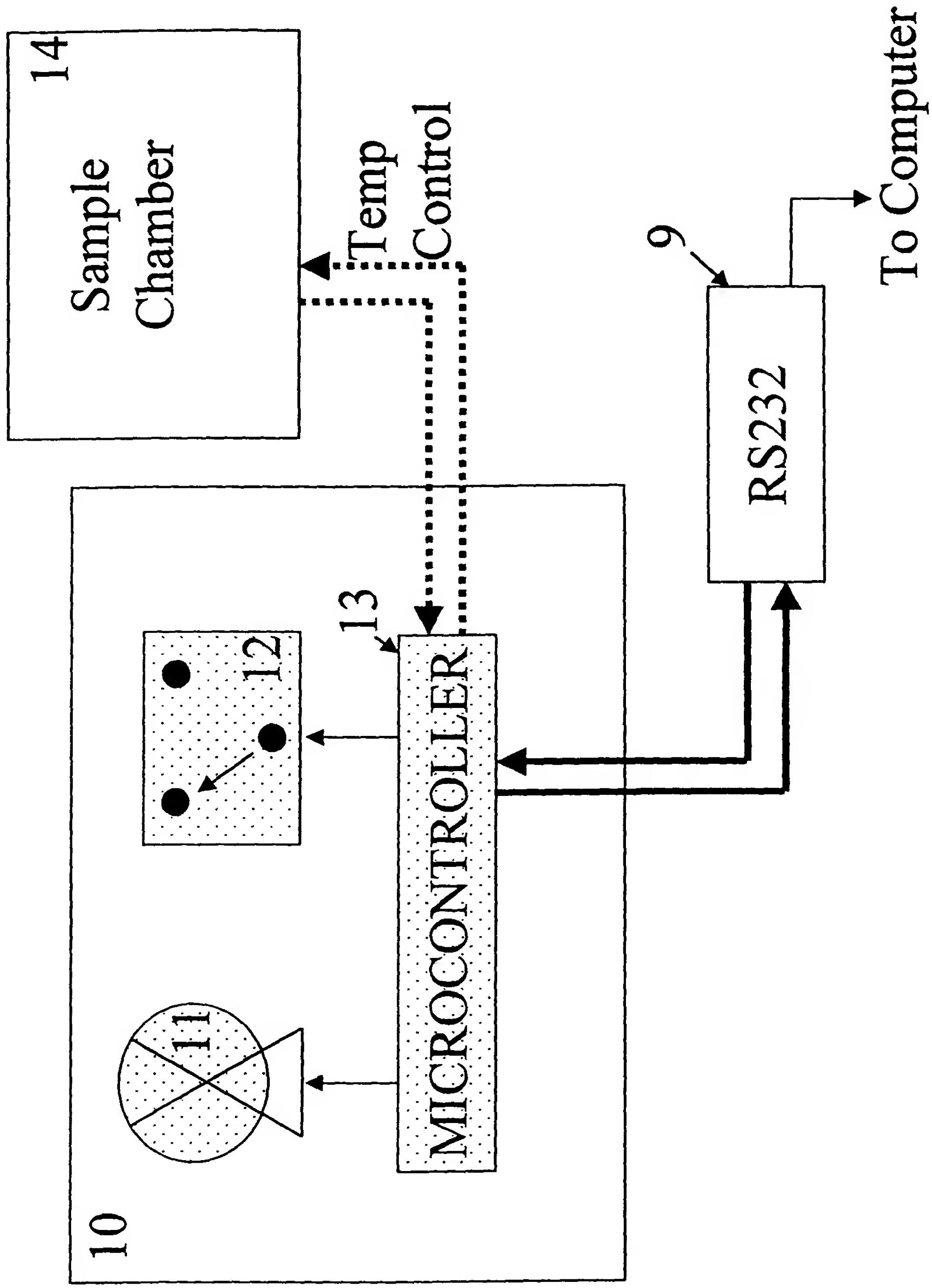
14
Sample Chamber
Temp Control
9
RS232
To Computer
13
12
MICROCONTROLLER
11
10

Figure 6

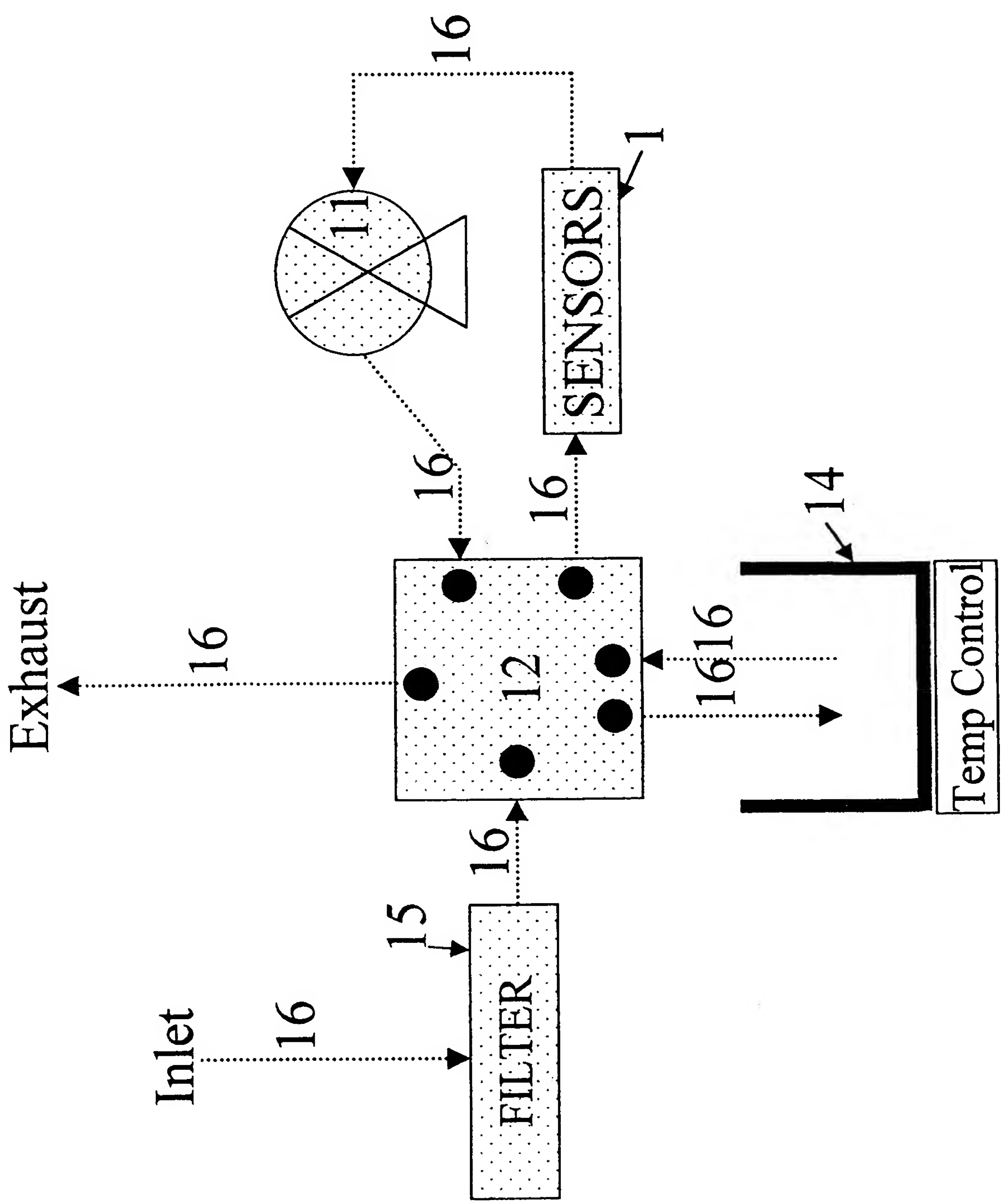

Figure 7A

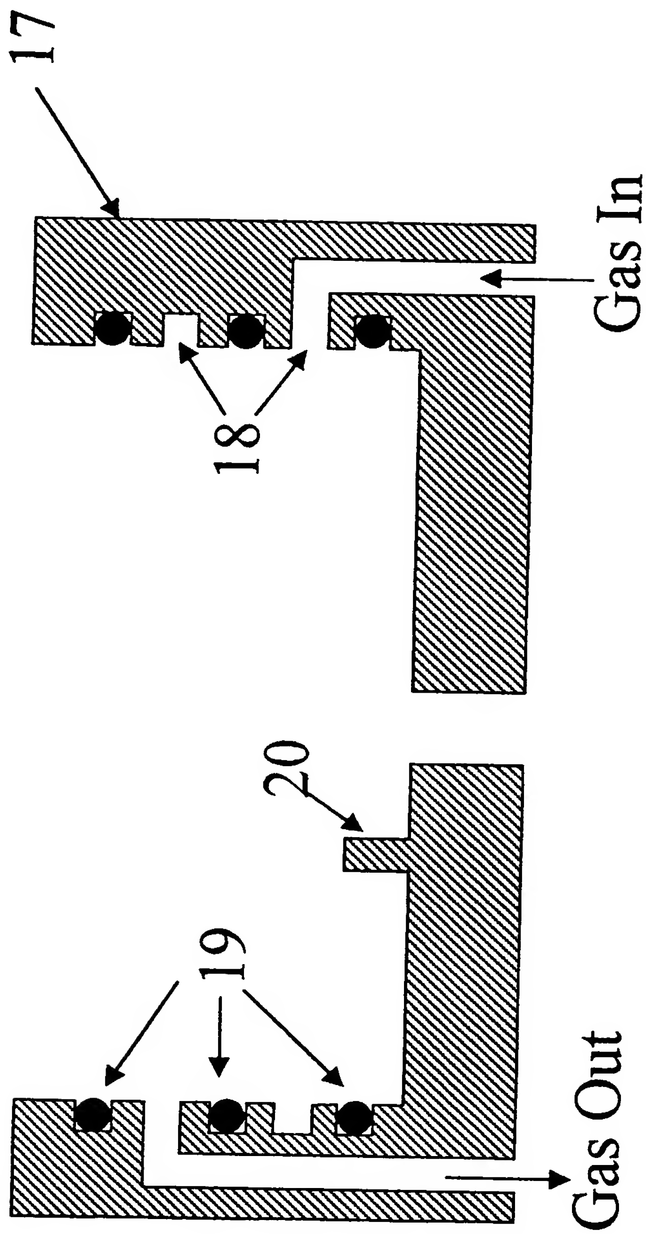

Figure 7B

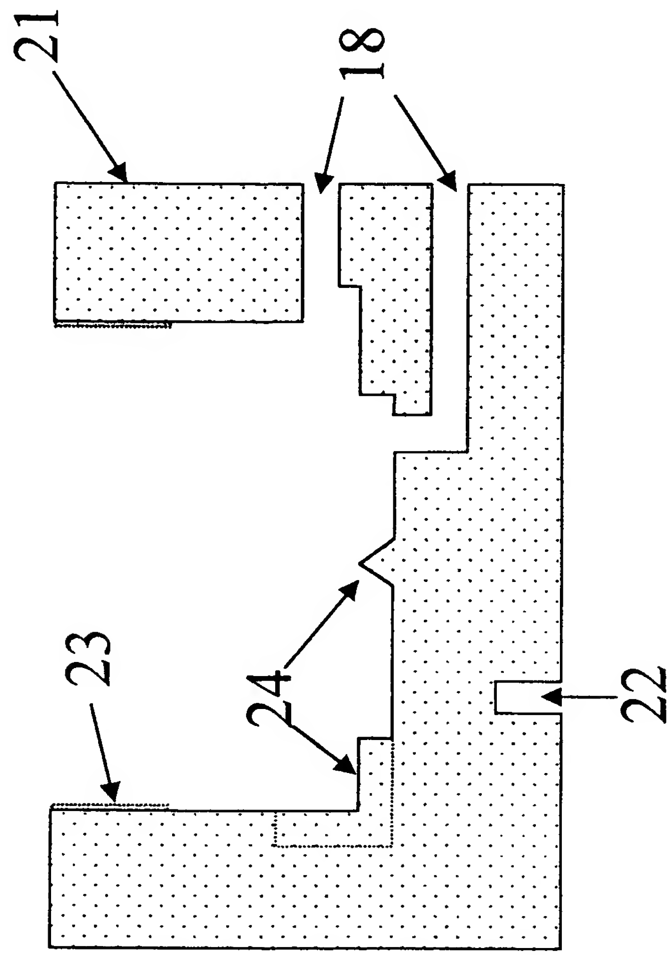

Figure 7C

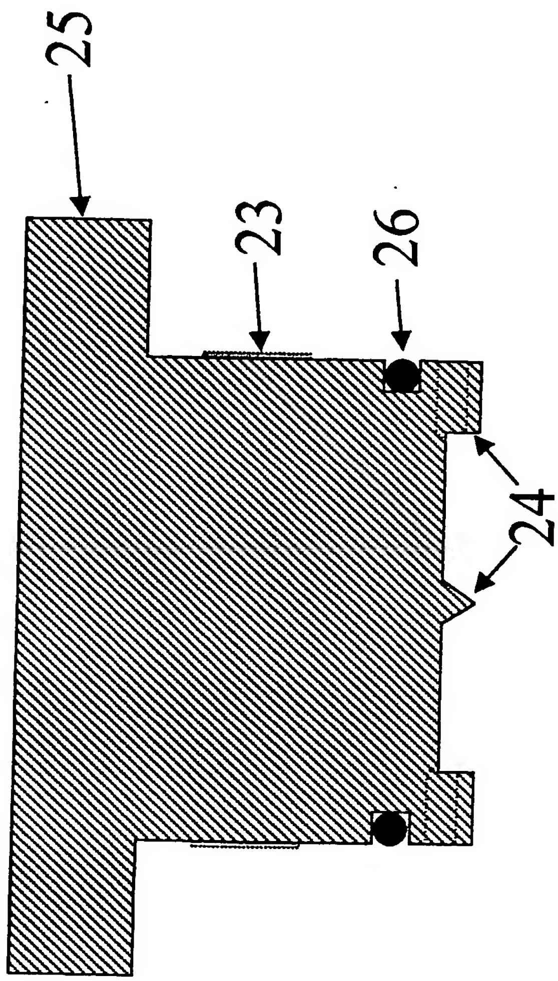

Figure 7D